Space Weather Forecast

Issued on Thursday, 14 December 2023 at 12:36 Local

This forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R2 Moderate Radio Blackout observed, further instances likely. Peak chance G1 Minor Geomagnetic Storm 16 December from CME arrival. Further CME(s) awaiting imagery.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose to Moderate in the past 24 hours, peaking with large, multiple-stage mid-ranking Moderate-class flare at 14/0744UTC from a sunspot region in the western solar hemisphere.

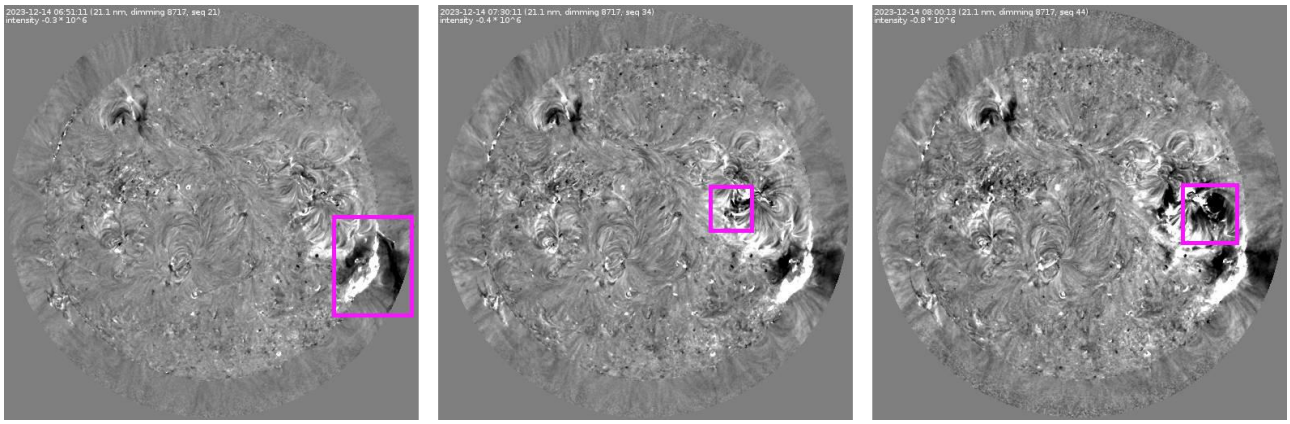

Figure 1: SIDC ROB-processed time integrated extreme UV imagery, showing multiple events leading into the 0744UTC Moderate class X-ray flare (tied to the rightmost dimming). Any CMEs from these events are awaiting imagery for analysis.

The sunspot region responsible was a large, complex and rapidly growing, with a notable increase in penumbral area (the visible orange haloes surrounding the dark spots themselves). The M-class flare itself was potentially sparked by a chain of events that started with a 'prominence eruption' (arc of plasma leaving the Sun) on the southwestern solar horizon around 14/0600UTC, which then potentially destabilised the sunspot region, with a modest flare in its trailer at 14/0720UTC, in turn perhaps priming the larger event of the M5.8 from its leading group.

The above sunspot region was one of eight on the current facing side of the Sun, although this does include four magnetically unipolar groups.

At least three separate Coronal Mass Ejection (CME) events were visible in satellite imagery of the last 24 hours. Firstly, a westward-directed event from narrowly over the western solar horizon during the UTC afternoon of 13 December. This has been analysed and bears no impact on the forecast Secondly, a low-latitude, apparently far-sided southeast-heading CME during the same UTC evening. No reliable measure of the source region is available for this part of the Sun, and the event appears below the plane of the Earth's orbit in any case. Thirdly, the 14/0600UTC

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'prominence eruption' became visible in the current UTC morning's imagery heading apparently southwest. This feature has yet to be analysed, but may tentatively bear some form of glancing incidence later in the forecast period. It is very possible from evidence (such as extreme UV dimming) that the Moderate-class flare event has also generated a CME along a more Earth-directed track that has yet to appear. These final (two?) events are of most interest and further imagery is awaited. At the time of writing no new CMEs were confirmed as Earth-directed.

Figure 2: Past 72 hours' flare locations of Common-class and above (recorded by the satellite PROBA2, white pixels), showing relative dominance of the sunspot tracing a path in the western solar hemisphere (mid-right). Processing courtesy of SIDC ROB.

Solar Wind / Geomagnetic Activity: Solar winds were initially at Background levels, but saw a step-wise enhancement in many measures that first occurred in a data gap between 13/2130-2230UTC. The causative event associated with this probable minor CME is not known, but its tenure was brief, with a resumption of Background winds by the end of the 24-hour reporting period.

The solar wind speed initially showed a declining trend within Background, before climbing back to previous highs after roughly 12/2100UTC. The number of particles featuring in the solar wind, which had previously fallen within background levels, rose to a slightly elevated peak near at 13/2300UTC before resuming its earlier decline. The magnetic field was perhaps the most marked solar wind measure: rising from an early stable trend at background to peak at slightly elevated levels, with the north-south component showing a heavy anti-aligned bias (with Earth's field, i.e. to general greater geomagnetic effect).

The net effect of the above solar wind measures was for rising geomagnetic activity, from initial quiet levels to a provisional peak of G1 Minor Geomagnetic Storm in the 03-06UTC interval, as reported by BGS.

Energetic Particles / Solar Radiation: No solar radiation storms were observed in the period, with the accompanying measure of this - the proton flux - remaining unmoved at background levels in the 24-hour period, despite the Modreate-class X-ray flare from a nominally exposed position.

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Four-Day Space Weather Forecast Summary

Solar Activity: Further Moderate-class flares are considered likely, with a slight chance of Strong-class, primarily from the large and complex western hemisphere sunspot group. No sunspot regions leave the facing side of the Sun in the period. The oncoming far eastern solar horizon is heavily populated with potential returning sunspot regions, however any contribution from these remains to be seen.

Solar Wind / Geomagnetic Activity: There is currently one CME in the forecast - that from 13 December from the large western hemisphere sunspot group, which is currently expected to arrive on day 3 (16 December) during the UTC morning with low confidence. Further potential CMEs from 14 December are awaiting imagery for analysis.

Otherwise, a 'coronal hole'-sourced fast wind is due within the current UTC day, easing into the UTC weekend. Winds are likely to peak at elevated levels, however confidence is currently low in both timing and peak wind strength.

There is a rising slight chance of Minor Geomagnetic Storm G1 conditions in the next 24 hours, then peaking with an eventual chance of a spell of Active to G1 Minor storms on day 3 (16 December) from any CME arrival, before reverting to Quiet later in the coming UTC weekend.

Energetic Particles / Solar Radiation: Solar radiation storms are now an increased risk in the first 12 hours given the Moderate-class X-ray flare from the western solar hemisphere at 14/0744UTC, although this now appears relatively unlikely to be associated with any enhancement given the intervening elapsed time. Despite the possible lack of proton enhancement with this event, the daily risk is nevertheless slightly higher than previously advertised given the new scale of X-ray activity in a prone location from the complex sunspot.

Geomagnetic Storms:

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	10	25	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X Ray Flares:

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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